

WATER USE IN MARCELLUS DEEP SHALE GAS EXPLORATION



FACT SHEET

JANUARY 2012

Marcellus Deep Shale Water Use

Water is an essential component of Chesapeake Energy Corporation's deep shale gas development. Chesapeake uses water for drilling, where a mixture of clay and water is used to carry rock cuttings to the surface, as well as to cool and lubricate the drillbit. Drilling a typical Chesapeake Marcellus deep shale gas well requires approximately 100,000 gallons of water.

Water is also used in hydraulic fracturing, where a mixture of water and sand is injected into the deep shale at a high pressure to create small cracks in the rock and allow gas to freely flow to the surface. Hydraulically fracturing a typical Chesapeake Marcellus horizontal deep shale gas well requires an average of 5.5 million gallons per well.

Water Use Consumption

The volume of water necessary to drill and fracture Marcellus deep shale gas wells represents a very small percentage of the total water resources used in the Marcellus geographic region. This region generally includes central and western Pennsylvania, southern New York and northern West Virginia. The total water used in the Marcellus Shale area in 2000 was approximately 3.6 trillion gallons. The natural gas industry is expected to increase the amount used by less than 0.1%, and is well within available resources in the region. Again, this volume is very small in terms of the overall water budget for this region. The largest water users in the Marcellus Shale geographic area

How much is 5.6 million gallons?

The 5.6 million gallons of water needed to drill and fracture a Marcellus deep shale gas well is equivalent to the amount of water consumed by:

- **New York City in eight minutes**
- **A 1,000 megawatt coal-fired power plant in 13 hours**
- **A golf course in 28 days**
- **Nine acres of corn in a season**

While these represent continuing consumption, the water used for a shale gas well is a one-time use.

KEY POINTS

- Water resources are protected through stringent state, regional and local permitting processes.
- Natural gas production uses significantly less water per BTU of energy produced than other fuel sources such as coal, oil or ethanol.
- Water is essential for Marcellus deep shale gas development.
- Marcellus deep shale gas drilling and hydraulic fracturing uses a small amount of water compared to other uses within the geographic area.

are power generation (approximately 72%), industry and mining (approximately 16%), and municipal/public water supply (approximately 12%). Agricultural water use accounts for only one-tenth of one percent in this area (0.10%). Water used in Chesapeake Marcellus deep shale gas operations differs most notably from all other uses because it is temporary, occurring only once during the drilling and completion phases of each well. Use of this water does not represent a long-term commitment of the resource in the Marcellus Shale geographic area.

Water Use Compared to Other Industry Sources

Water and energy are interdependent. Water is essential to energy resource development. Conversely, energy resources are needed for producing, processing, distributing and using water resources. A typical Marcellus deep shale gas well will produce approximately 4.2 billion cubic feet (Bcf) of gas over its lifetime, the amount of water used to produce the gas equates to about 1.3 gallons for every million British thermal unit (MMBTU - one MMBTU equals about a thousand cubic feet of gas). To put this in perspective, this is approximately 15% of the water needed to produce one MMBTU of coal that is ready to burn in a power plant or 0.05% of the water needed to produce the same energy equivalent of ethanol for fuel. The table on the following page compares water use per unit of energy for several energy sources.

Water requirements for various energy resources

Energy Resource ¹	Range of Gallons of Water Used per MMBTU of Energy Produced
Marcellus Shale Natural Gas	0.95 ²
Conventional Natural Gas	1 – 3
Coal (no slurry transport)	2 – 8
Coal (with slurry transport)	13 – 32
Nuclear (uranium ready to use in a power plant)	8 – 14
Chesapeake Deep Shale Oil	7.96 – 19.25 ³
Conventional Oil	8 – 20
Synfuel - Coal Gasification	11 – 26
Oil Shale Petroleum	22 – 56
Oil Sands Petroleum	27 – 68
Synfuel - Fisher Tropsch (from coal)	41 – 60
Enhanced Oil Recovery (EOR)	21 – 2,500
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

¹Source: "Deep Shale Natural Gas: Abundant, Affordable, and Still Water Efficient", GWPC, 2010.

²The transport of natural gas can add up to two gallons per MMBTU.

³Includes refining which consumes a major portion (90%) of the water needed (7-18 gal per MMBtu).

Water Sources

Chesapeake utilizes a variety of sources of water in Marcellus deep shale gas exploration. The sources include rivers, creeks and lakes. Chesapeake is also reviewing the use of a variety of other water resources such as discharge water from industrial or city wastewater treatment plants, groundwater and reuse of fracturing water. Chesapeake often works directly with local officials to arrange water purchases from a municipality when drilling inside city limits. Water is typically transported by truck to drilling locations for storage prior to use in tanks or impoundments. Chesapeake also uses temporary pipelines to transport water supplies. Due to the extensive and diverse geographic area overlying the Marcellus Shale, the overall mix of water sources used depends on the region and the availability of sources near drilling sites.

Water Regulations

Regardless of the source, water used in Chesapeake's drilling and fracturing process is purchased and, if necessary, properly permitted. This permitting ensures that water used for drilling and hydraulic fracturing does not interfere with the available supply for other users. In addition, both Pennsylvania and New York require an impact analysis to ensure that the surface water

withdrawals will not harm the watershed or other users. The assessments ensure that our use will not adversely affect stream flow, aquatic life, recreational resources or sensitive environments.

In the Marcellus Shale area, regional river authorities have jurisdiction in multiple states. The federally established watershed authorities have been created to protect the water quality of the entire river basin and regulate uses of the water. Additional approvals and permits are required for operations in these river basins. Chesapeake actively works with the Delaware River Basin Commission and the Susquehanna River Basin Commission to obtain water for use in Pennsylvania and New York.

Chesapeake's deep shale gas development, with its comparatively small water use per unit of energy, is consistent with the nation's energy/water strategy by making a positive energy and economic contribution at a relatively low cost to the overall water supply. Chesapeake's deep shale gas has the potential to supply decades of natural gas for the U.S., while using less water than other currently available viable energy sources.

Information Sources

- Argonne National Laboratory
- Delaware River Basin Commission
- Ground Water Protection Council (GWPC)
- Sandia National Laboratory
- Susquehanna River Basin Commission
- U.S. Department of Energy (DOE)
- U.S. Geological Survey

About Chesapeake

Chesapeake Energy Corporation is the second-largest producer of natural gas, a Top 15 producer of oil and natural gas liquids and the most active driller of new wells in the U.S. Headquartered in Oklahoma City, the company's operations are focused on discovering and developing unconventional natural gas and oil fields onshore in the U.S. Chesapeake owns leading positions in the Barnett, Haynesville, Bossier, Marcellus and Pearsall natural gas shale plays and in the Granite Wash, Cleveland, Tonkawa, Mississippi Lime, Bone Spring, Avalon, Wolfcamp, Wolfberry, Eagle Ford, Niobrara, Three Forks/Bakken and Utica unconventional liquids plays. The company has also vertically integrated its operations and owns substantial midstream, compression, drilling, trucking, pressure pumping and other oilfield service assets. For more information on Chesapeake environment initiatives, visit the environment section of CHK.com, HydraulicFracturing.com, NaturalGasAirEmissions.com, NaturalGasWaterUsage.com, AskChesapeake.com or FracFocus.com.